EARLY HISTORY OF TROPICAL STORM KATHERINE, 1963

CARL O. ERICKSON AND SIGMUND FRITZ

U.S. Weather Bureau, Washington, D.C.

ABSTRACT

The history of the Eastern Pacific tropical cyclone, Katherine, is presented for the period September 8–17, 1963. It is shown that Katherine was the same storm as one which earlier had been named Jennifer.

The complementary nature of surface ship observations and satellite cloud photographs is well illustrated by this particular case. The experience suggests that both forms of data are essential to improved analyses and forecasts over data-sparse areas such as the tropical Eastern Pacific.

1. INTRODUCTION

On the morning of September 17, 1963, a ship near Guadalupe Island reported 45-kt. winds from the south-southeast, rough seas, and a pressure of 1000 mb. Operationally, this was the first real indication of the existence of tropical storm Katherine [1]. At that time (1600 GMT) the ship *Etnefjell*, which radioed the report, was positioned near 28° N., 117° W., less than 150 mi. from the coast of Baja California.

Katherine was moving northeastward at approximately 20 kt. at the time of its discovery. It entered extreme northwestern Mexico on the evening of the same day and caused heavy rains and considerable crop damage over portions of southern California and Arizona [2]. Record rainfall occurred at Yuma, Ariz.

Except for the shipping lanes lying just off the west coasts of Mexico and Central America, the tropical Eastern North Pacific is a vast region of few meteorological data, and it is not at all surprising that Katherine should have escaped earlier detection. At the time, forecasters suspected that Katherine was, or may have been, derived from, Jennifer—an earlier storm known to have existed several hundred miles to the south. However, they were unable to establish the relationship, because of lack of sufficient evidence.[1] Jennifer had moved past Socorro Island (19° N., 111° W.) on September 12 and then westward into an area of no data. Bulletins on Jennifer were continued until 0000 GMT, September 15, at which time the storm was thought to be dissipating near 19° N., 122° W.

On the basis of ships' logs and other data subsequently received, it appears that Jennifer and Katherine were in all probability the same cyclone, as was suspected. It also appears that this cyclone has a history from as early as September 8, when it was a recognizable disturbance near the Gulf of Tehuantepec.

The purpose of this paper is to show, with the aid of both satellite and conventional data, that Jennifer and Katherine were the same storm, since a reasonable continuity in space and time can be demonstrated. It is extremely doubtful that this could have been accomplished using either data source alone. Thus, if both forms of data were available operationally, improved analyses, and therefore improved forecasts, could be made in the Tropics.

2. CHRONOLOGY

Figure 1 is a composite showing the earliest information to indicate that an organized disturbance was taking shape. The TIROS photograph for September 8 (upper left) reveals a large cloud mass near the horizon toward the east. The high oblique view permits only a crude estimate of the center of the cloud mass, which is placed near 13° N., 96° W. A spiral structure within the cloud mass may exist but is questionable. The mosaic of photographs for September 9 (upper right) shows the same cloud mass near the eastern horizon (in the vicinity of the L-shaped fiducial mark at the far right) but with no discernible suggestion of spiral structure. Other cloud masses, which were not there on the previous day, appear southeast of Baja California. On September 10, the TIROS picture (lower right) again reveals the cloud mass, now better organized and with definite indications of spiral structure, centered near 14° N., 104° W.

These high oblique TIROS views would not necessarily signify a storm by themselves, but a ship in the area recorded a wind of 34 kt. at 0000 GMT, September 10 (see map at lower left, fig. 1). That observation, showing an east-southeast wind and pressure 1004 mb., was obtained from the log of the *Priamos* (a freighter of German registry); the observation fits very nicely with the surrounding data to indicate a cyclonic disturbance that was perhaps barely of tropical storm strength.[2, 3]

[1] Personal communication from Mr. Corday Counts, Meteorologist-In-Charge, Weather Bureau Airport Station, San Francisco, Calif. See also Wilgus [1].

[2] The U.S. Weather Bureau definition of a tropical storm is: "a tropical cyclone with closed isobars and highest wind speeds of 34 to 63 kt., inclusive."

[3] It should be pointed out that the observations from the *Priamos*, as well as some others used in this paper, were not available to the operational analysts and forecasters.

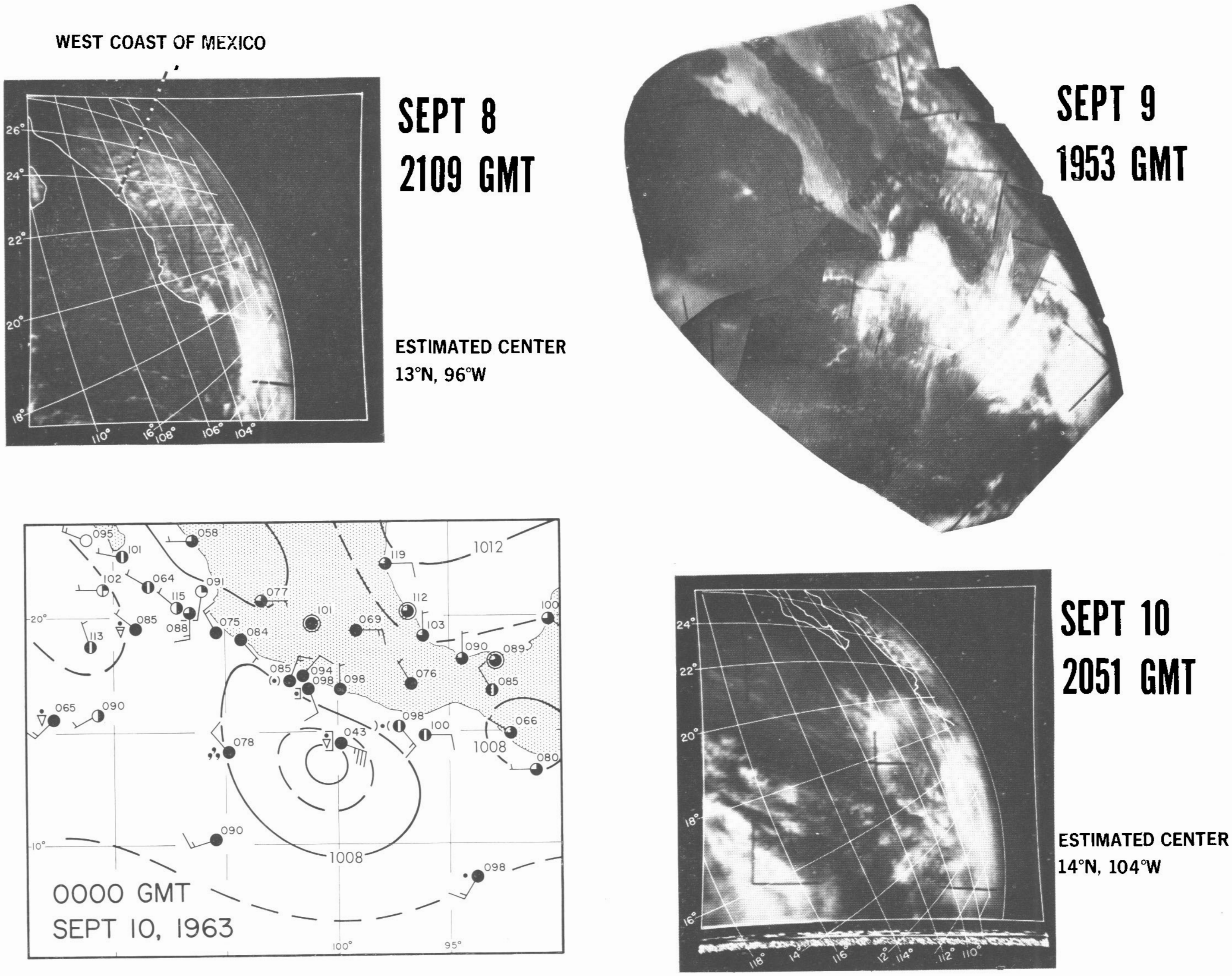

FIGURE 1.—TIROS VI and VII photographs of the area southwest of Mexico on September 8–10, 1963, showing disturbance near the eastern horizon. Surface analysis over same area for 0000 GMT, September 10, is shown at lower left. Plotted data include only sky cover, wind, pressure, and present weather.

A plot of all 6-hourly observations from the *Priamos* for a 2-day period is shown in figure 2. These provide further evidence that the ship passed slightly north of the center of a small tropical storm about 0000 GMT, September 10. The absence of large swells significantly different from the wind-driven waves indicates that the disturbance probably only recently had attained tropical storm intensity (see table 1 for sea and swell code). Not again until September 17, shortly before the cyclone moved inland over northwestern Mexico nearly 1,500 mi. away, was there another surface observation from so near the storm center.

Figure 3 contains a mosaic of TIROS pictures taken on September 11. Unfortunately, this was the only time during the history of the cyclone that the central area of the storm was photographed from a nearly vertical view. The eye is faintly visible near 15° N., 107° W. Landmarks permitted a location accuracy which is probably within 1° of latitude.

These pictures show the cloudiness in the storm area

TABLE 1.—*Synoptic reporting code for sea and swell conditions (group $1d_wd_wP_wH_w$), where 1 is identifier, d_wd_w is the direction from which the waves are coming (to 36 points), P_w and H_w are the period and height, respectively*

P_w (coded)	Period (sec.)	H_w (coded)	Height (ft.)
2	5 or less	0	Less than 1.
3	6–7	1	1½.
4	8–9	2	3.
5	10–11	3	5.
6	12–13	4	6½.
7	14–15	5	8.
8	16–17	6	9½.
9	18–19	7	11.
0	20–21	8	13.
1	Over 21	9	14.

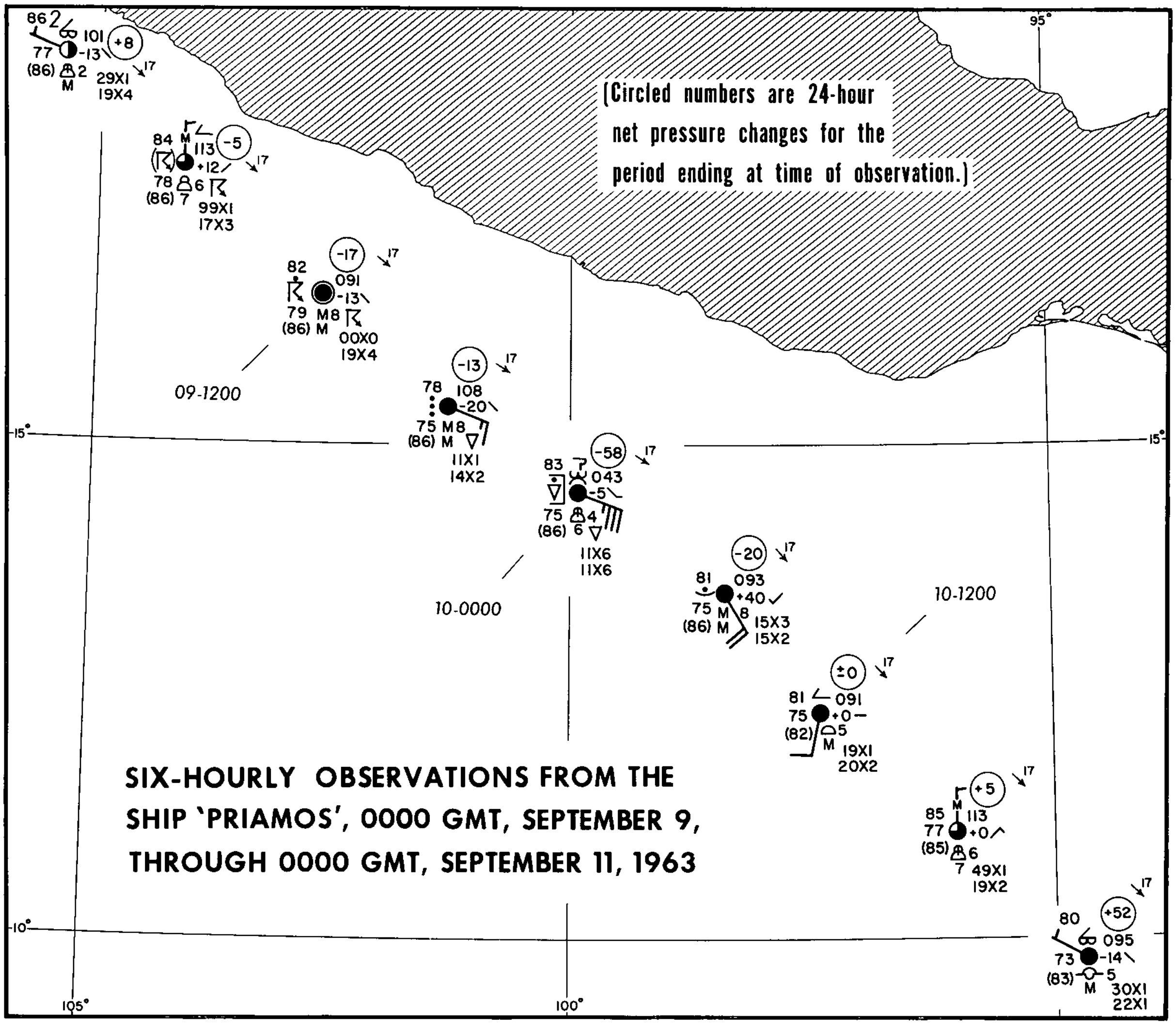

FIGURE 2.—Six-hourly synoptic observations from the ship *Priamos* for September 9 and 10, 1963. The two 4-digit groups at the lower right of each plotted report are the coded sea and swell conditions ($d_wd_wP_wH_w$), the lower group in each case representing the swells. See table 1 for explanation of code.

was moderately well-organized, with the disk-shaped overcast surrounding the eye approximately 3° of latitude in diameter. Using a preliminary semi-objective technique,[4] we estimate that the maximum sustained surface winds associated with the cyclone were 55 to 60 kt. This estimate has not been verified because there were no available surface or aircraft observations from the vicinity of the cyclone on that day. As far as is known, no reconnaissance or other aircraft flights entered the storm area on any day during the lifetime of the cyclone.

On the next day, September 12, at 1200 GMT, Socorro Island (19° N., 111° W.) reported easterly winds of 45 kt. [1]. At that time the storm was named Jennifer. Subsequent reports from Socorro Island showed east and southeast winds until 0000 GMT, September 13, indicating that the cyclone, then called Jennifer, was moving on a westward or northwestward track passing south of the island (see fig. 9 for the storm track). Operationally, bulletins on Jennifer were continued until 0000 GMT, September 15, although little information was available to forecasters.

Two swaths of satellite photographs, each covering fringes of the storm, were taken on September 14 and 15, respectively (see fig. 4). In both cases spiral cloud bands are visible, and on the September 15 photo there also exists a rather sharp edge on the southeastern side of the main spiral-band mass. This well-marked edge suggests that the adjacent narrow clear zone that is visible may be part of a more extensive annular zone. Such a feature has been described by Fett [3] as one often observed in photographs of well-developed tropical cyclones.

In both picture swaths of figure 4 the center of the apparent vortex is outside the photographed area, and

[4] A technique for estimating maximum surface winds in tropical cyclones from satellite cloud photographs of those cyclones has been developed empirically in the National Weather Satellite Center, using satellite and reconnaissance data obtained during the years 1961–63, inclusive. The essential entry parameters are the size of the overcast disk and the degree of organization of the spiral band structure. Initial results appear promising in estimating wind speeds in those cases where information other than satellite photographs is not available. The technique is explained by A. Timchalk, L. F. Hubert, and S. Fritz in Meteorological Satellite Laboratory Report No. 33 (in preparation).

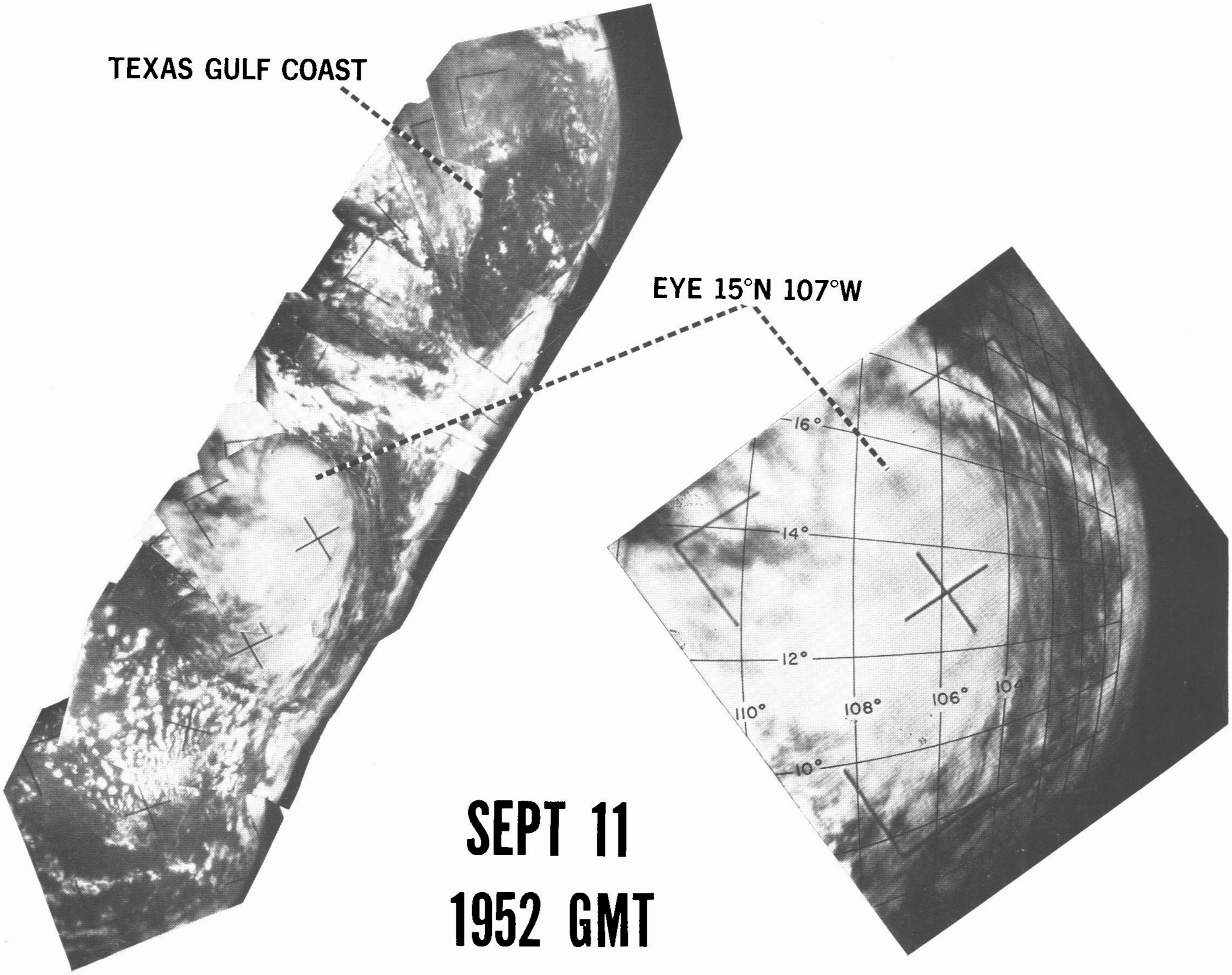

FIGURE 3.—Mosaic of TIROS VI photographs (pass 5232/5229, camera 1) and single-frame gridded picture showing tropical storm southwest of Mexico. Picture time approximately 1952 GMT, September 11, 1963. The eye is located near 15° N., 107° W.

only approximate estimates of its position can be made. These estimated positions are based on the appearance of that portion of the spiral band configuration that is within the field of view, and on latitude-longitude grid overlays fitted to individual pictures. Although the estimates are necessarily crude, they agree rather well with surface indications from the logs of two ships which were approaching the area during this time. The surface analyses based on those ship observations (not shown here) place the track of the center about 50 to 100 mi. south of the estimated positions on figure 4.

The organized outer bands, the sharp cloud edges, and the partially visible annular zone in the pictures of figure 4 suggest that the cloud area associated with the cyclone was larger than it was on September 11 and was at least as well organized. It is entirely possible that the maximum winds could have been of hurricane force during a part of this September 14–15 period, although the lack of data makes this uncertain.

Operationally, at 0000 GMT on September 15, advisory bulletins on tropical storm Jennifer were discontinued because the storm was believed to be dissipating. Bulletins advising of a tropical depression in the area were continued, however. About two and one-half days later, at 1800 GMT, September 17, tropical storm Katherine was identified and named in an area several hundred miles to the north and was tracked to the Mexican coast. But the picture swaths of figure 4 indicate that the photographed cyclone—even though incompletely seen—was in fact Jennifer on September 15. And it can be shown that Jennifer (later named Katherine) was the same storm which later crossed the coast of northern Baja California on September 17. Two items may be cited to support this view: (1) On September 14, the large nearly cloud-

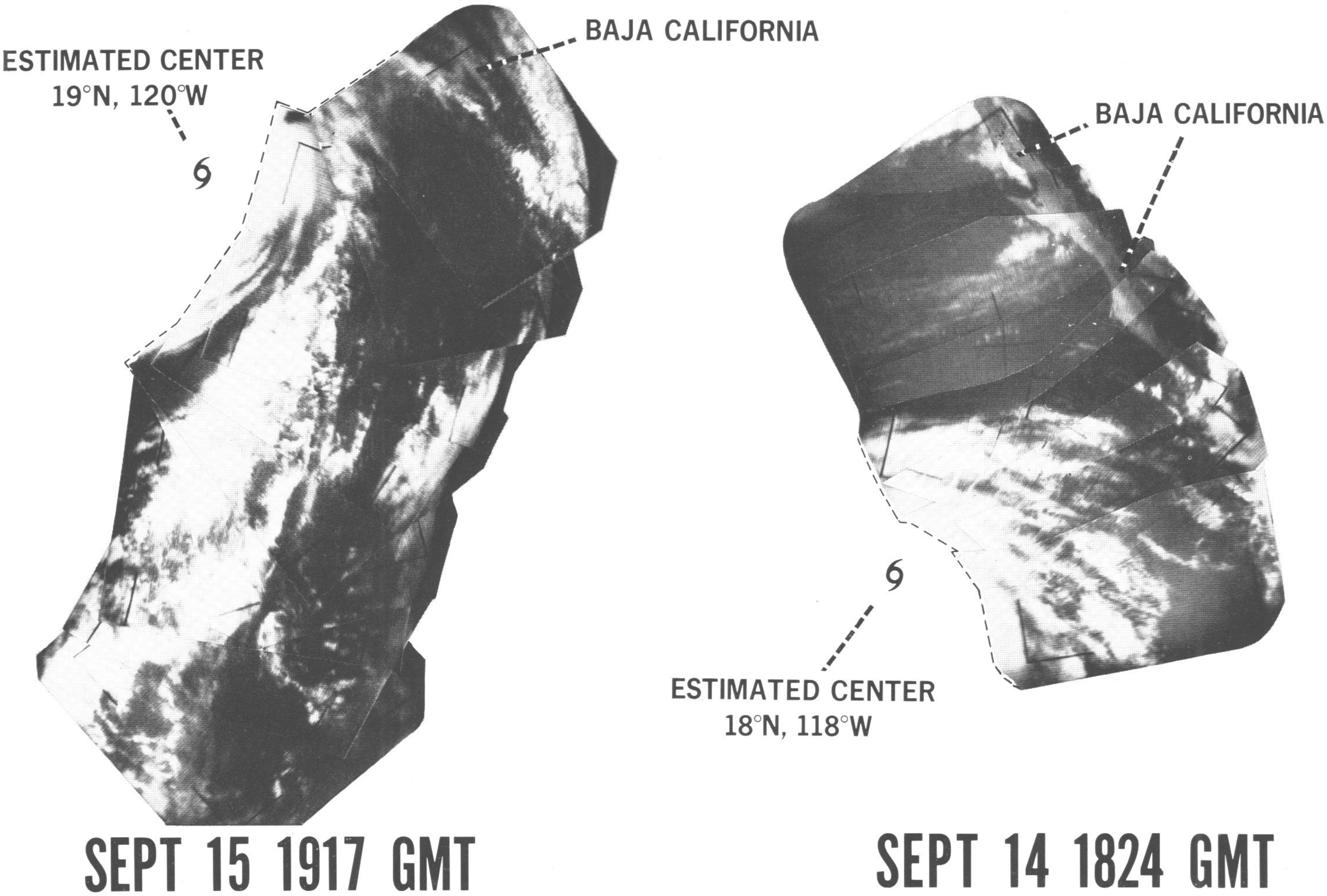

FIGURE 4.—Fringe views of storm area on September 14 and 15, 1963. Pictures on September 14 (right) taken by TIROS VII, camera 1, pass 1291—direct, at approximately 1824 GMT. Pictures on September 15 (left) taken by TIROS VI, camera 1, pass 5288/5286, at approximately 1917 GMT. Dotted lines indicate edges of the photo swaths across storm area.

free region in figure 4 north of the cyclone and west of Baja California indicates the absence of any other disturbance within the photographed area which could have become Katherine; (2) On September 16–17, the northward movement of the storm is evident from the synoptic data presented in figures 5–7.

The surface analysis for 0000 GMT, September 16, is presented in figure 5. Reports from the logs of two ships, previously mentioned as approaching the storm area during September 14 and 15, are plotted on this map. These two reports provide further evidence that the cyclone continued to exist and was centered somewhat north of the ships' positions.

An interesting sidelight is the fact that two other tropical disturbances also existed within the borders of the map shown in figure 5. The remains of tropical storm Irah are centered near 22° N., 148° W., and the incipient stages of hurricane Cindy are located over the western Gulf of Mexico.

Figures 6 and 7 show the 6-hourly surface analyses for September 16 and 17. All available ship reports for each synoptic hour are plotted, but for each ship the only data shown are wind, pressure, sky cover, present weather (when reported), and sea swells (when reported). Most of these reports were obtained from the ships' logs.

From 0000 GMT, September 16, through 1200 GMT, September 17, there were no observations or satellite photographs from the area near the center of the cyclone. The analyses and storm track, presented in figures 6 and 7, are therefore necessarily based on peripheral indications plus the assumption of a reasonable continuity. In addition to the evidence for northward movement from wind and pressure data, a number of ships off the coast of Baja California reported continuing moderate or heavy swells from directions between south and west during this period, indicating the existence of a recent or continuing storm somewhere to the southwest. Other ships along the Mexican coast reported swell directions which, for the most part, agreed with the storm locations in figure 6.

During this September 16–17 period, particularly at 1200 GMT on September 16, there is some evidence for the existence of a weak secondary Low, centered near 130° W. and between 15° and 20° N., some distance southwest of the primary northward-moving cyclone. It is not clear

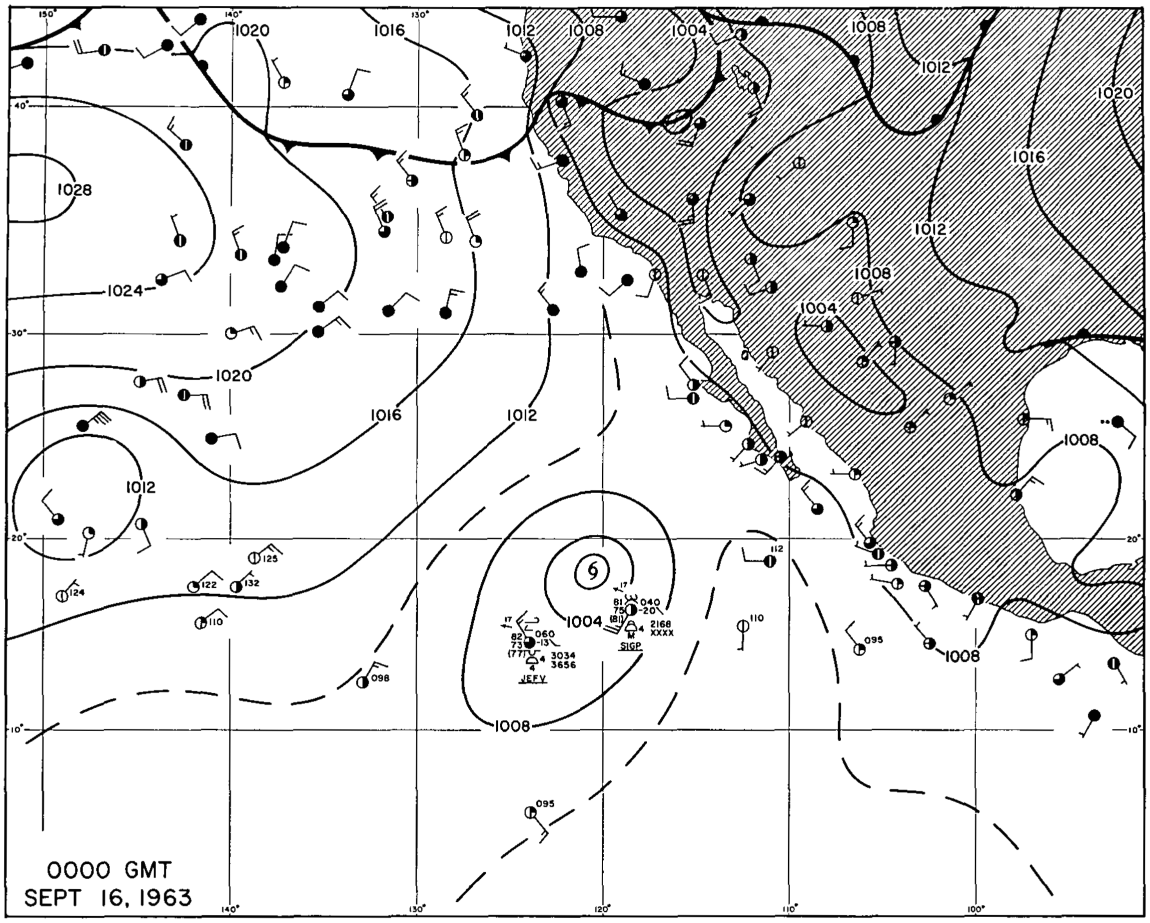

FIGURE 5.—Surface analysis for 0000 GMT, September 16. All available ship reports for the Pacific area are plotted (in most cases only wind and sky cover are shown).

whether this weak Low formed as a breakoff from the primary circulation or whether it existed in this region prior to the approach and passage of the tropical storm.

By 1800 GMT, September 17, two ships near Guadalupe Island (29° N., 118° W.) and near the approaching circulation were reporting winds of 30 and 45 kt., respectively, and pressures of 1000 mb., so that the center is fairly accurately located. Those two reports were received operationally, and the storm was named Katherine at that time. During the next 6 to 12 hr., before the cyclone moved inland, winds of 50 kt. were experienced by several vessels [1].

TIROS photographs of portions of the western and southern quadrants of the storm area were taken at approximately 1750 GMT, September 17. These photographs are not shown because little or no part of the central cloud mass appears in the pictures. They do suggest that a considerable amount of the cloudiness, in those quadrants which were photographed, was low-level stratocumulus entering the circulation from the west and northwest. The more stable conditions usually associated with such cloudiness, and the colder water existing at the higher latitudes to which the cyclone had then penetrated might have weakened the storm during the several hours before landfall.

Figure 8 presents the 500-mb. analyses for September 16 and 17, essentially taken from the maps of the National Meteorological Center. There are of course no upper-air data over the area of the tropical cyclone, but the data north of latitude 30° N. indicate an increasing-amplitude upper-air trough along the west coast of the United States during this time. Dunn and Miller [4] and others have cited such large-amplitude troughs extending southward from the westerlies as favorable for the recurvature and northward movement of tropical cyclones. The fact that such an upper-air pattern existed in this case north of 30° N. cannot prove that upper-air conditions were favorable for a northward movement of the tropical storm in the lower-latitude region between 20° and 30° N. However, this has strengthened the belief that the northward storm track indicated on figures 6 and 7 is, in all probability, substantially correct. The 6-hourly analyzed central positions on figures 6 and 7 correspond to a forward speed of approximately 10 kt. early on September 16, increasing to about 20 kt. late on the 17th.

The complete storm track, up to 0000 GMT, September 18, is presented in figure 9. Part of the surface analysis for that hour also is shown.

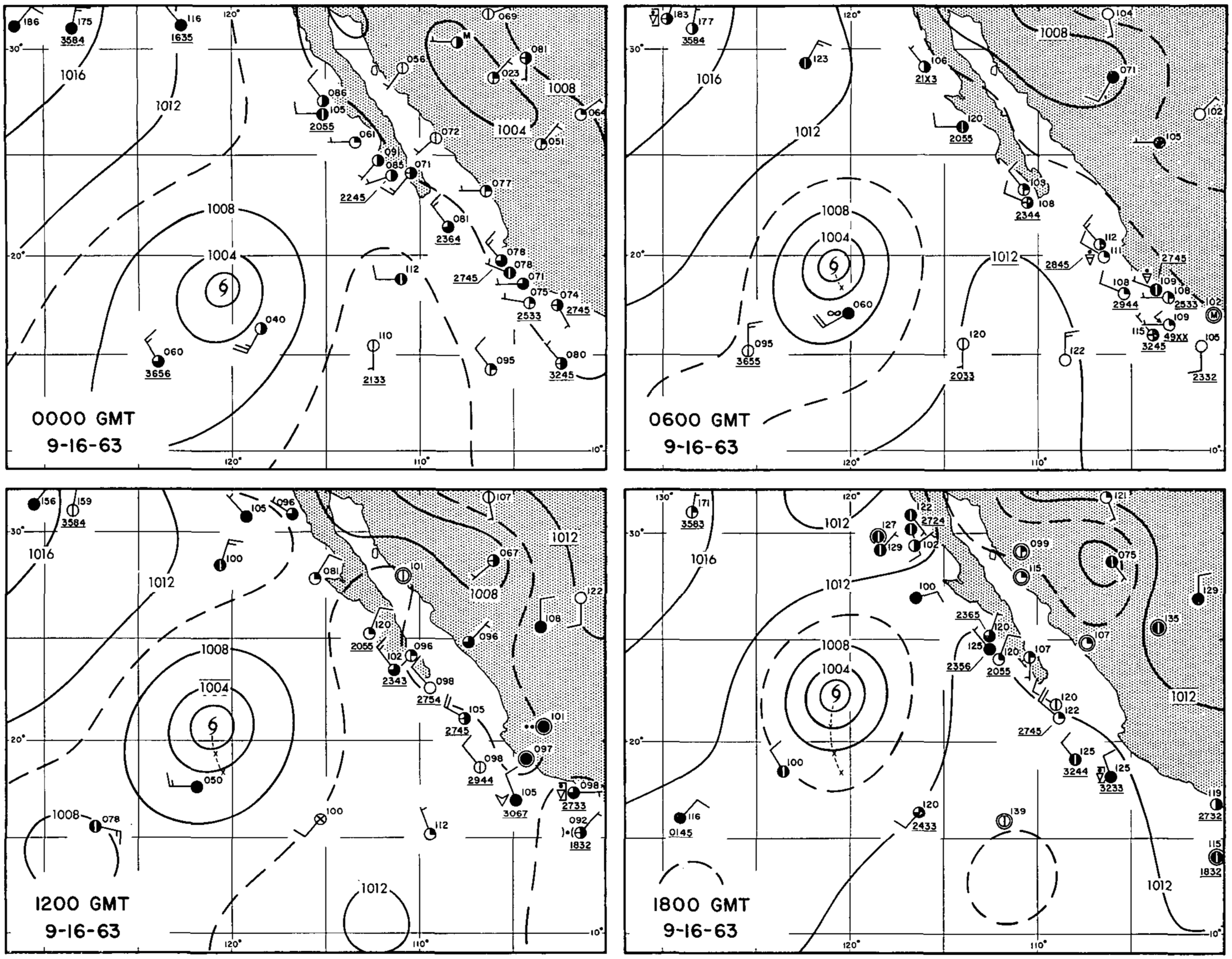

FIGURE 6.—Six-hourly surface analyses in vicinity of storm, September 16, 1963. All available ship reports are plotted (wind, sky cover, present weather, pressure, and sea swells, only). The 4-digit underlined group is the coded direction, period, and height of the swells, where reported (see table 1 for explanation of code). Dotted line indicates storm track and estimated 6-hourly past positions from 0000 GMT, September 16.

3. DATA SOURCES

The surface ship observations for this study were obtained from several sources. For the area of immediate interest—that region lying between 10° and 30° N., and between 100° and 130° W.—the primary sources were ships' logs. However, a number of reports within that area were obtained from copies of operationally-prepared synoptic analyses and from teletypewriter data. For the oceanic region outside the described area, the principal sources were the operational analyses and teletypewriter data. No one category was all-inclusive.

The surface map for 0000 GMT, September 16 (fig. 5) provides a good illustration of the general data situation over the Eastern North Pacific. All available ship reports have been plotted, but except for the two complete reports in the vicinity of the storm (and a few others at which the pressure is indicated) only the wind and the sky cover are shown. The coverage is perhaps slightly better than average, and is better than that usually available to the operational forecaster. Even so, there are two adjacent 10° "squares" (20°–30° N. and 120°–140° W.) without a single observation! This is typical because major shipping lanes do not traverse that area. If the two completely plotted reports were removed from figure 5, there would be almost no indication from conventional data of the existence of the tropical storm. Such situations undoubtedly have occurred many times in the past, causing storms to go undetected. Sadler [5] gives a more thorough discussion of the data generally available over the tropical Eastern North Pacific and the known climatology of the region. He claims that satellite photographs available in recent years indicate that the

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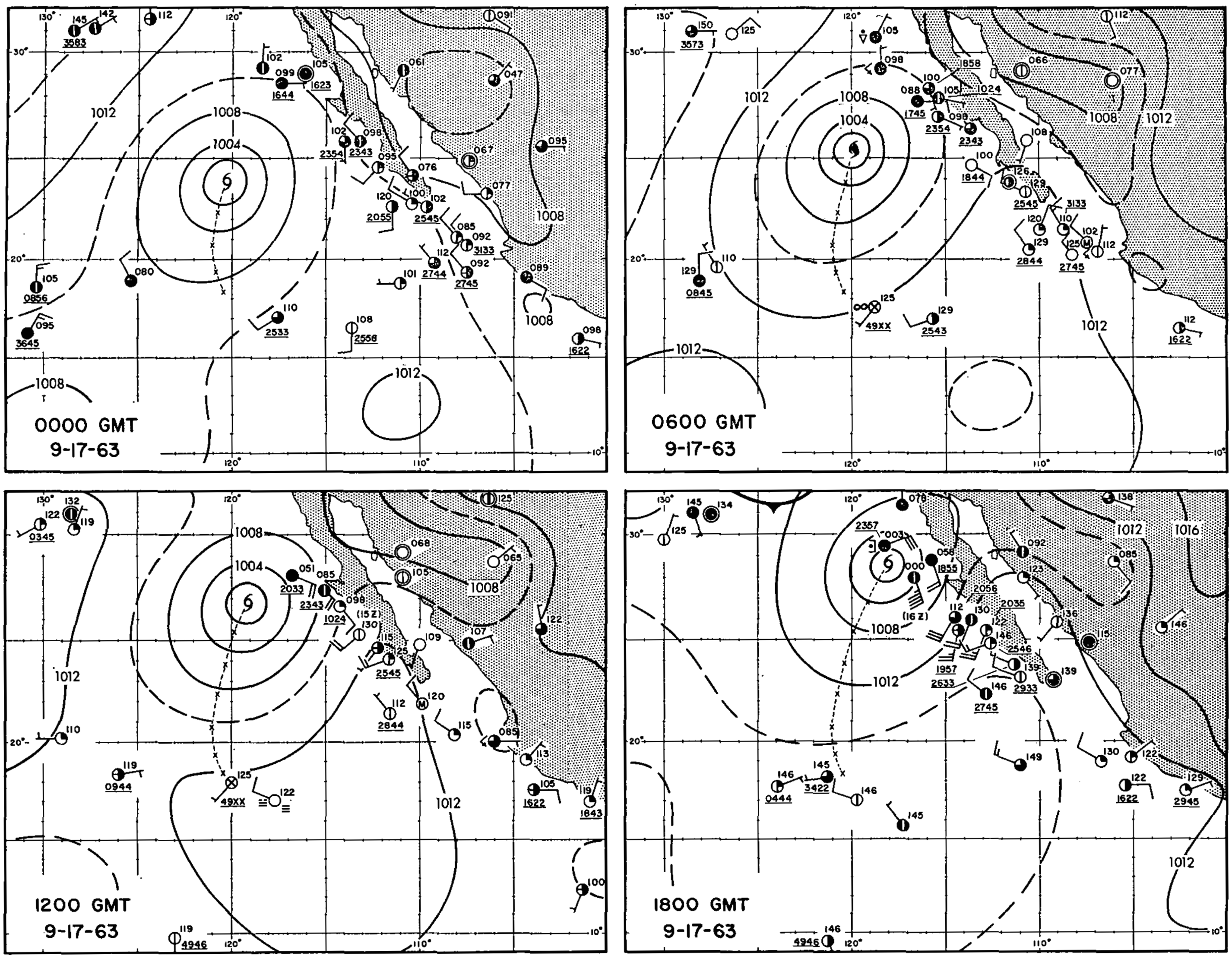

FIGURE 7.—Six-hourly surface analyses for September 17. See legend for figure 6.

tropical storm and hurricane frequencies may be as much as three times as great as those previously determined from the sparse conventional observations. Rosendal [6] also describes the hurricane climatology of the area, and has pointed out that storms often are followed during only a part of their life.

Another interesting sidelight in the present study is the unusually large number of ship reports available at 0000 GMT, September 18, from the area off Baja California. There were so many of them that not all could be plotted on the chart shown in figure 9. At that time, advisories on Katherine had been issued and observations requested from ships in the area; some of the reports normally would not have been received.

4. CONCLUSION

In summarizing the history of tropical storm Katherine, and the track as presented in figure 9, it appears that neither the ship reports alone, nor the satellite photographs alone, would have been sufficient to establish the track of the storm. It would be very desirable to have satellite photographs for September 16 to confirm the peripheral indications of northward movement; unfortunately, no pictures of the area were received on that day. For the earlier days, September 8, 11, and 14, there are no conventional data from near the center, but TIROS photographs were taken on those days. The combination of satellite and conventional data, in this case, makes it evident that Jennifer and Katherine were the same storm. Generally, the need for both types of data could be expected to be even greater for operational analysis and forecasting purposes, particularly for this part of the world where the conventional data are so sparse.

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Several persons and organizations were helpful in supplying the necessary data. In particular, the assistance of Mr. Corday Counts, Meteorologist-in-Charge at the Weather Bureau Airport

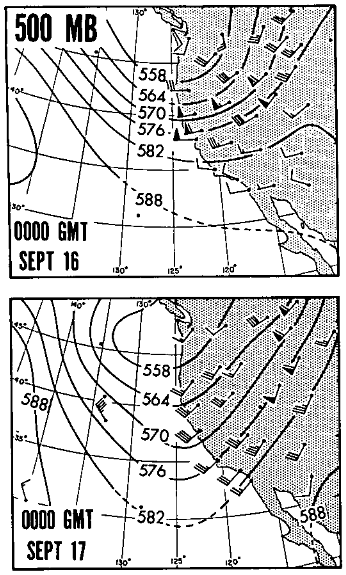

FIGURE 8.—500-mb. analyses for September 16 and 17, 1963. Contours labeled in 10's of g.p.m. Dotted lines denote lower-latitude contours that are relatively less definite.

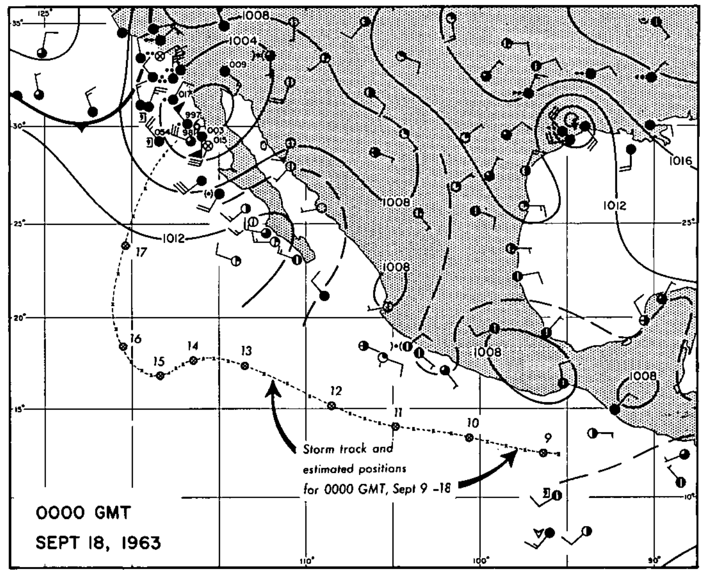

FIGURE 9.—Surface analysis for 0000 GMT, September 18, 1963, and storm track for September 9–18. The symbols ⊗ indicate the estimated central positions at 0000 GMT.

Station, San Francisco, Calif., and Mr. Hans Rosendal, USWB Office of Climatology, Washington, D.C., in obtaining data is gratefully acknowledged.

REFERENCES

1. R. V. Wilgus, "Tropical Cyclones of the Eastern North Pacific, 1963," *Mariners Weather Log*, vol. 8, No. 2, Mar. 1964, pp. 38–40.
2. D. M. Ludlum (editor), *Weatherwise*, vol. 16, No. 6, Dec. 1963, p. 297.
3. R. W. Fett, "Aspects of Hurricane Structure; New Model Considerations Suggested by TIROS and Project Mercury Observations," *Monthly Weather Review*, vol. 92, No. 2, Feb. 1964, pp. 43–60.
4. G. E. Dunn and B. I. Miller, *Atlantic Hurricanes*, Louisiana State University Press, 1960, 326 pp.
5. J. C. Sadler, "Tropical Cyclones of the Eastern North Pacific as Revealed by TIROS Observations," *Journal of Applied Meteorology*, vol. 3, No. 4, Aug. 1964, pp. 347–366.
6. H. E. Rosendal, "Eastern North Pacific Tropical Cyclones 1947–1961," *Mariners Weather Log*, vol. 6, No. 6, Nov. 1962, pp. 195–201.

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